INTERNAL WORKING DOCUMENT

Root Deformities In Plantations

There is much controversy over root deformities of planted bare-root stock (particularly pine) and different types of container stock. Tree instability problems associated with root deformation have been documented in different countries (Burdett, 1978; Chavasse, 1978). In New Brunswick, trees in some bare-root pine plantations have been observed falling over after eight to ten years. It has also been suggested that similar serious problems may result from root deformities associated with various container types.

This report attempts to describe generally what is happening in New Brunswick plantations and relate this to some of the literature. The procedure was to assess the lateral stability and extent of root deformities of trees (particularly jack pine) in older plantations established by the Department of Natural Resources.

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CONTENTS

	Page
Method	2
Stability	2
Roots	3
Results	4
Root Form	4
Bare-root	4
Paper pots	4
Tap root development	7
Root development on Finnish Plow Sites	7
Tree Stability	
Discussion	13
Root Form	13
Stability	14
Summary	16
Appendix I Photos of roots collected from plantations during root deformity study in 1980.	17

LIST OF TABLES

		Page
Table 1	Plantations sampled in 1980 to assess root development.	5
Table 2	Amount of paper remaining in paper pot plantations when sampled in the summer of 1980.	8
Table 3	Tap root development of planted jack pine when surveyed in 1980.	9
Table 4	Direction(s) of apparent root development on finnish plow sites sampled in 1980.	10
Table 5	Percent of trees in each stability class when sampled in 1980.	12

LIST OF FIGURES

Figure 1	Adventitious roots on a planted spruce tree.	6
Figure 2	Fusing of spiralled roots with development of a common vascular system.	6

METHOD

In the summer of 1980 sample lines were traversed through sixteen 3 to 14 year old plantations on Crown land in New Brunswick. All plantations were jack pine except three spruce plantations. At regular intervals sample points were located and the closest tree in each of the quandrants was chosen as a sample tree.

STABILITY

Each tree was grasped approximately one third to one half the distance up the stem and pushed approximately 15° - 20° laterally in all directions to estimate it's stability. Each tree was classified into one of five stability classes.

Class 1. obviously firm, stem bends before root moves (if any), resembles natural tree.

Class 2. generally firm in all directions; however roots can be moved with stem.

Class 3. intermediate, definitely worse than Class 2, but not as bad as Class 4; tree "works" in ground in all directions but not really weak in any one direction.

Class 4. tree easily moved in one or more directions, roots absent or very loose on one or more sides.

Class 5. tree already leaning noticeably because of poor rooting system.

ROOTS

Sample roots (up to 20 per plantation) were excavated and labelled with a metal tag. On Finnish plow sites the root was marked to show its' orientation relative to the plowed row. All samples were returned to Fredericton, photographed and preserved.

RESULTS

ROOT FORM

General

Table 1 lists the plantations examined along with basic information on each. Due to the difficulty involved in describing root systems, all samples have been photographed and the photographs are included in Appendix I for examination.

Bare Root

Most roots from these plantations show deformities of some sort. Although few of the classical "J" root type were found, most were deformed into almost any pattern imaginable. Some roots appeared to have been knotted prior to planting and some appeared to have been twisted into the planting hole.

Good symmetrical orientation of lateral roots was often missing. Some showed a vertical plane orientation indicative of a planting slit. Others had roots oriented in one direction only. In most cases it was obvious that the root shape had changed little since the time of planting.

Plantation P-12-70 which was spruce, has a more symmetrical arrangement of support roots due to the adventitious rooting of the spruce. Figure 1. shows good development of adventitious roots from above the root collar.

Paper Pots

Generally, roots of paper pot stock had a better appearance than roots of bare-root stock. Lateral orientation of roots was more symmetrical. However, root one-sidedness was often

Table 1. Plantations Sampled in 1980 to assess root development

Stock	Species	Year Planted	Site Preparation	Height (meters)	Region	Area (ha)	Location	File #	Remarks
Bare-Root	jP	1966	No Site Prep	5.0	1	13	Baranaby River	P-3-66	No Root Samples
	jP	1970	No Site Prep	4.3	4	8	Utopia	P-4-70	
	wS	1970	Finnish Plow	2.1	1	36	L.S. Tracadie R.	P-12-70	
	jP	1972	Finnish Plow	3.0	1	153	L.S. Tracadie R.	P-9-72	
	jP	1973	Finnish Plow	2.6	1	115	L.S. Tracadie R.	P-2-73	
	jP	1974	Finnish Plow	2.6	1	74	Big Hole Brook	P-4-74	
	jP	1974	Marden Roller	2.2	3	93	Gaspereau River	P-13-74	planted by Irving
	jP	1975	Barrels	1.3	2	24	Cold Brook	P-7-75	
	jP	1975	Barrels	1.8	3	35	Walten Glen	P-8-75	
	jP	1976	Barrels	1.8	3	139	L. Salmon River	P-3-76	
Paper Pots	jP	1973	Finnish Plow	2.5	1	47	Nine Mile Brook	TP-1-73	
	jP	1973	Finnish Plow	1.8	2	20	Beaverbrook	TP-3-73	
	jP	1974	Finnish Plow	2.5	1	348	Big Hole Brook	TP-1-74	
	jP	1974	Finnish Plow	2.0	3	43	Gaspereau River	TP-2-74	planted by Irving
	jP	1975	Barrels	1.8	3	62	L. Salmon River	P-8-75	
	jP	1976	Barrels	1.7	4	34	Keswick River	TP-10-76	
	bS	1976	Barrels	0.9	4	37	Keswick River	TP-10-76	
	bs&wS	1977	Root Rake	---	5	28	Moose Valley Bk	TP-11-77	Root Sample Only

Figure 1. Adventitious roots on a planted spruce tree.

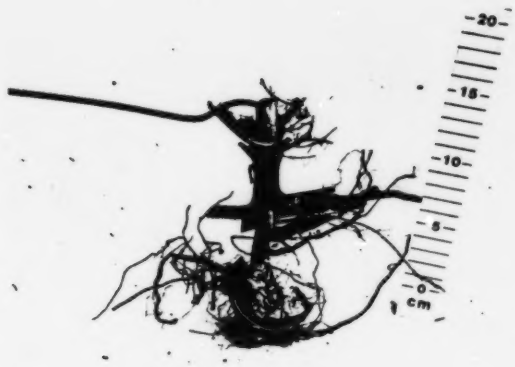
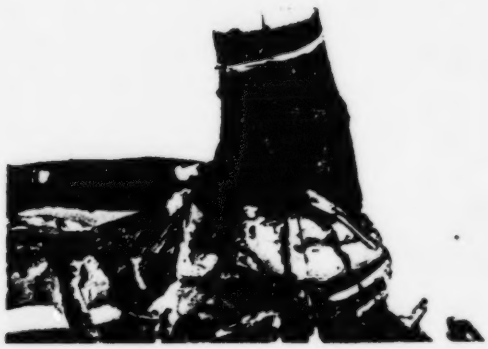
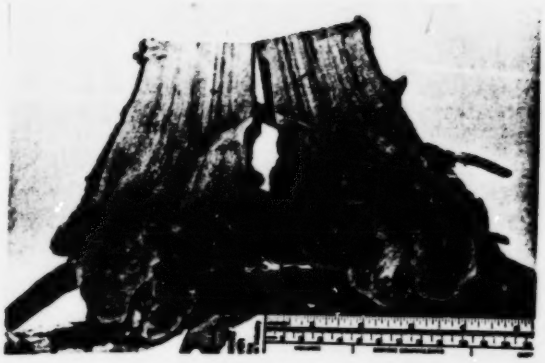


Figure 2. Fusing of spiralled roots with development of a common vascular system.





found. As with bare-root spruce, paper pot spruce showed development of adventitious roots (TP-10-76, TP-11-76).

Most paper pot root systems showed some degree of root spiralling. In many cases roots have sprialled 180° it appears even after emerging from the paper. However, Figure 2. shows that these spiralled roots fuse over time. In fact, this fusion is such that no example of a root strangled by another was found.

Even though lateral orientation of paper pot roots appeared better than roots of bare-root stock, many were of fibrous nature (large number of small roots) which appeared out of balance considering the size of the tree.

Table 2. gives the amount of paper degradation for paper pot plantations. This is a subjective classification, but indicates paper is present up to 7 years after planting.

Tap Root Development

Table 3. lists all jack pine plantations with respect to tap root development. Trees classified as having "poor tap roots" had small, poorly developed tap roots to the point that it is questionable whether many fit the definition of a tap root. Very few sturdy tap roots of classical shape were found.

Root Development on Finnish Plow Sites

Table 4. shows the orientation of lateral roots with respect to the finnish plowed row. Roots of 15 trees were so malformed it was impossible to classify them for this Table. There was no consistant orientation of lateral roots with respect to the plow row.

Table 2. Amount of paper remaining in paper pot plantations when sample in the summer of 1980.

File No. & Year Planted	Species	Percent of the trees in each class		
		More than 25% of paper pot remaining	Less than 25% of paper pot remaining	No paper pot remaining
TP-1-73	jP	50	40	10
TP-3-73	jP	12	63	25
TP-1-74	jP	10	58	32
TP-2-74	jP	20	80	0
P-8-75	jP	20	60	20
TP-10-76	jP	20	50	30
TP-10-76	bS	95	5	0

Table 3. Tap root development of planted jack pine when survey in 1980.

Stock Type	File No & Year	Percent of trees in each class: Tap root present	Poor tap root present	No discernable tap root
Bare Root	P-4-70	43	14	43
	P-9-72	20	0	80
	P-2-73	10	20	70
	P-4-74	100	0	0
	P-13-74	10	10	80
	P-7-75	5	0	95
	P-8-75	0	0	100
	P-3-76	5	35	60
Paper Pots	TP-1-73	20	40	40
	TP-3-73	5	5	90
	TP-1-74	6	0	94
	TP-2-74	20	50	30
	P-8-75	25	25	50
	TP-10-76	0	20	80

Table 4. Direction(s) of apparent root development on finnish plow sites, sampled in 1980.

Stock	Species	File No & Year Planted	# Samples	Direction(s) of Apparent Growth			
				Toward Center	With Row	Away from Center	Uni-Form
Bare-Root	wS	P-12-70	1			*	
			9				*
	jP	P-9-72	1	*			
			1	*	*		
			4	*		*	
			1		*	*	
			2			*	
			6				*
	jP	P-2-73	5	*			
			4	*		*	
			4			*	
	jP	P-4-74	2	*			
			3	*	*		
			3	*		*	
			1				*
Paper Pots	jP	TP-1-73	2	*			
			1	*	*		
			1	*		*	
			1		*		
			2		*	*	
			1			*	
			2				*
	jP	TP-3-73	1	*			
			1	*		*	
			5		*		
			2			*	
			2				*
	jP	TP-1-74	2	*			
			3	*	*		
			1	*		*	
			1		*		
			1		*	*	
			3			*	
			6				*
	jP	TP-2-74	4	*			
			1		*		
			2			*	
			13				*

TREE STABILITY

Table 5. shows the percentage of sample trees which fall within each stability class. It should be recognized that to put trees into discrete stability classes is subjective. However, all sampling was done by only one technician, eliminating human judgement differences. Consequently, comparisons can be made among individual plantations.

To facilitate more meaningful interpretation of the stability of trees in each class, several Departmental staff members were asked to give their impression of the stability of the typical tree within each class. The following is their collective opinion:

Class 1. very stable, will reach maturity

Class 2. acceptably stable - will probably reach maturity;

Class 3. intermediate, probably some trees will firm up in time, others may fall over - grey area of indecision;

Class 4. unstable, will not reach maturity;

Class 5. unstable, will not reach maturity

Spruce plantations were more stable than jack Pine plantations. Some jack pine trees of both bare root and paper pot stock types were unstable.

Table 5. Percent of trees in each stability class when sampled in 1980. "1" is firm and "5" is leaning and loose.

Stock	Species	File No and Year Planted	# Sample Trees	% of Sample Trees by Stability Classes				
				Stable		Intermediate	Unstable	
				1	2	3	4	5
Bare Root	jP	P-3-66	48	15	75	10	--	-
	jP	P-4-70	28	18	71	11	--	-
	wS	P-12-70	48	8	88	4	--	-
	jP	P-9-72	100	10	67	15	7	1
	jP	P-2-73	100	4	63	23	2	8
	jP	P-4-74	80	--	55	26	16	3
	jP	P-13-74	100	1	88	11	--	-
	jP	P-7-75	100	--	92	8	--	-
	jP	P-8-75	40	--	70	25	5	-
	jP	P-3-76	40	--	60	27	5	8
Paper Pots	jP	TP-1-73	52	2	73	25	--	-
	jP	TP-3-73	100	--	59	35	6	-
	jP	TP-1-74	100	--	78	19	2	1
	jP	TP-2-74	100	--	87	13	--	-
	jP	P-8-75	92	--	82	15	3	-
	jP	TP-10-76	100	--	85	14	1	-
	bS	TP-10-76	100	--	92	8	--	-

DISCUSSION

ROOT FORM

From observation of these samples it is evident that the form of jack pine bare-root trees have changed very little if any the first years after planting. Spruce trees however, seem more forgiving to poor planting because of their adventitious rooting habit.

Paper pot roots bore little resemblance to natural roots. That root spiralling exhists is without question. However, from sectioning of samples, it is obvious that spiralled roots fuse and do not strangle each other. This is the accepted thinking in most literature (Grene, 1978; Hagner, 1978; Gillgren, 1972; Armson, 1978). Although these roots fuse, the result is often a knot of solid wood with a large number of small roots protruding from it. The paper pot induces a deformity - the question is how significant is this deformity.

Degradation of the type(s) of paper pot used in the past is very slow considering Table 2. Plantation TP-1-73 for example lists 50 percent of the root samples as having a notable amount of paper present. However, there is variation. Plantations TP-1-73 and TP-3-73, both having the same original stock produced at the same nursery, were established on two different sites. TP-3-73 was planted on a wet site and shows significantly higher degree of paper degradation than does TP-1-73 which was planted on a much drier site. Also, TP-10-76 (spruce) and TP-10-76 (pine) were planted side by side on the same site but have different amounts of paper present. Possibly the roots of the pine grew faster than

those of spruce and sloughed off the paper sooner rather than the paper degrading faster.

The notable absence of tap roots on both bare-root and paper pot jack pine must be of considerable significance for a species which usually establishes them (Armson, 1977). It was noted that the few trees with good tap roots were usually in stability Class 1. or Class 2.

There has been some opinion among DNR staff that trees planted on plowed sites have asymmetrical root development due to the extremes of exposed mineral soil on one side and a mound of organic soil on the other. Such development was found in Sweden and Nova Scotia (Stefansson, 1978). However, none of the plantations examined in this survey showed any consistent, obvious pattern (Table 4).

STABILITY

With reference to Table 5 there is definitely a range in stability in both the bare-root and paper pot plantations sampled. It should be noted here that TP-3-73 (least stable of the paper pot plantations) was planted on a very wet site, often in the center of the plowed row, and had high mortality. Many of the remaining plants had obviously been frost heaved. Since this was a species planted poorly, "off-site" it should be excluded for stability comparisons.

The two spruce plantations (P-12-70 and TP-10-76) were stable. This is probably due to the development of an adventitious root system. Armson (1978) states this characteristic is a saving factor for any species which develops this type of rooting.

P-3-66 and P-4-70 show that bare-root jack pine can be stable ten to fourteen years after planting. Root samples were not collected from P-3-66, but root samples from P-4-70 seem less deformed than other plantations with 57 percent of the samples having fairly good tap roots. Considering this, good, stable bare root jack pine plantations can develop if planted carefully on the right site.

Considering that the Provincial nurseries are phasing out of bare-root jack pine, the question remains what will the stability of paper pot jack pine stock be as a plantation ages. From this survey it appears the question is what will happen to the trees in the "intermediate" stability zone. As the plantations mature, will significant numbers move into stability Class 2. or stability Class 4? The "Proceedings of the Root Form of Planted Trees Symposium" which was held in British Columbia in 1978 gives evidence of a varying degree of opinion concerning this. Grene (1978) suggests that root deformities associated with different container types may cause stability hazards at some time. Hagner (1978) on the other hand believes that trees will stabilize over time. A study of 12-25 year old container (varying types) plantations done in Sweden (Gillgren, 1972) concludes that even deformed roots can develop satisfactorily.

The "intermediate" trees may firm up in later years. During the period of moderate stability, however, plantations may be susceptible to freak storms with extra strong winds or wet snowloads. Only time will demonstrate the merits of paper pots in New Brunswick.

SUMMARY

1. All plantations sampled had deformed roots.
2. Spiralled roots in paper pots have not strangled each other but have fused into a solid ball of wood and share a common vascular system.
3. Spruce plantations have developed adventitious roots and are very stable.
4. The paper in paper pots is still present after seven years in some cases.
5. There was no obvious distortion of root symmetry which could be related to Finnish plowed sites.
6. Jack pine plantations have not developed good tap roots.
7. There is a range of stability in both bare-root and paper pot plantations.
8. Good stable older jack pine bare-root plantations were found. This indicates that on the right sites well planted jack pine bare-root trees can form acceptable plantations.
9. Because no paper pot jack pine plantations more than 7 years old were sampled there is uncertainty as to the future stability of the paper pot jack pine plantations, however they appear to be more stable than bare-root jack pine plantations.

APPENDIX

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